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**Extended abstract**

**Active public health surveillance for foodborne infections: The FoodNet program in the United States**

**Robert V. Tauxe, M.D., M.P.H., Jennifer M. Nelson, M.P.H., Frederick J. Angulo, D.V.M., Ph.D.. Foodborne and Diarrheal Diseases Branch, Division of Bacterial and Mycotic Diseases, National Center for Infectious Diseases, Centers for Disease Control and Prevention, Atlanta, Georgia, U.S.A.**

Public health surveillance of foodborne infections is important to measure the burden of these infections on the public health, to detect outbreaks, to determine sources of infection, and to assess the impact of control and prevention measures. In the United States, as in many other countries, the requirements for which infections should be reported and the vigor with which reporting occurs vary substantially from one jurisdiction to another. This makes it difficult to evaluate observed geographic differences in rates, and to estimate the public health burden of diseases or to interpret trends over time. Beginning in 1996, we have developed and implemented a new strategy of public health surveillance for selected foodborne infections in the United States, FoodNet, that supplements the existing notifiable disease reporting system. FoodNet is a collaborative network of State health departments, academic schools of public health, CDC and the food regulatory agencies of the U. S. Department of Agriculture and the Food and Drug Administration. It is conducted through the CDC Emerging Infectious Diseases Program, which established sentinel surveillance sites in states. At these sites, additional resources make it possible to regularly contact each clinical laboratory in the area, collecting reports of all diagnoses of certain categories of infections likely to be foodborne. This active outreach means that all diagnosed infections of interest are identified, eliminating the effect of geographic differences in routine reporting requirements. This provides regular and rapid data on the changing incidence of the infections under surveillance. FoodNet currently covers infections with *Campylobacter*, *E. coli* O157, Non O157 Shiga toxin-producing *E. coli*, hemolytic uremic syndrome, *Listeria monocytogenes*, *Salmonella*, *Shigella*, *Yersinia enterocolitica*, *Cryptosporidium*, *Cyclospora*, and foodborne outbreaks. The cost of the FoodNet program is approximately \$7 million per annum.

Any surveillance captures only a fraction of infections, as some who are ill do not seek care, and some who seek care are not cultured, and some who are cultured may have a false negative cultures result. It is important to know the degree of under-reporting, so that the actual incidence of infections can be estimated. Therefore, FoodNet sites also conduct surveys of the population to determine the frequency of gastrointestinal syndromes in the population, the frequency with which they seek medical care for such conditions, and the frequency with which they are cultured. Using the information from these surveys, it is possible to evaluate the efficiency of traditional passive surveillance and to construct the "pyramid of illness", and the burden of infections. For example, it has been estimated that for each case of salmonellosis that is reported through traditional surveillance, an additional 39 illnesses actually occurred (Voetsch et al, 2004).

The same survey is also used to determine detailed population-based measures of exposure to a variety of foods and other risks, including foreign travel, swimming, visiting farms

and other animal contacts. These periodic surveys are published regularly as "Atlas of Exposures" which provides background exposure information across season, and geography, as well as age and ethnic groups (CDC 2004a). This means that in the outbreak setting, when a suspect exposure is identified among cases, the likely background exposure of the population at large can be determined immediately, providing an early read on whether case exposure rates are unusually high. As it is possible that laboratory practices also could differ from one geographic region to another, FoodNet has also conducted surveys of diagnostic laboratories to determine the typical methods and reagents used, and the frequency with which laboratory tests for specific organisms are performed. This provides a unique window into the range of practices of clinical laboratories; to date, few important regional differences have emerged.

FoodNet investigators have field tested innovations in the practice of public health. For example, a recent FoodNet study looked at the impact of providing specimen collection kits to the home of patients involved in foodborne outbreaks (Jones et al. 2004). The etiology of the majority of foodborne outbreaks is not identified, largely because adequate specimens are never collected. In this study, use of a prepackaged diagnostic kit resulted in collection of specimens and diagnosis in 71% of outbreaks, at a courier shipping cost of approximately \$43 per specimen returned. We are now encouraging other states throughout the nation to adopt similar systems.

FoodNet also provides a platform for conducting more detailed research into the sources of sporadic infections. We have conducted large multi-site epidemiologic case-control studies of sporadic infections with *Salmonella* of several serotypes, *Campylobacter*, *E. coli* O157:H7, *Cryptosporidia* and *Listeria monocytogenes*. These studies identify typical risk factors and exposures for these infections with these organisms, that sometimes differ from the information gathered during outbreaks of those same infections. For example, sporadic infections with *Campylobacter* are associated with eating poultry and other meats outside of the home, while outbreaks are most often associated with consuming raw unpasteurized milk (Friedman et al, 2004). The first case-control study of *E. coli* O157:H7 infections showed that eating undercooked ground beef was a risk factor, as was visiting a farm with dairy cattle, but eating at fast-food restaurants, which had been well documented as a risk in the early 1990's, was no longer a risk factor (Kassenborg et al. 2004).

FoodNet began with five sites in 1996, and had expanded to 10 sites by 2003; an eleventh site is under development now. In 2003, the population under surveillance was 42 million, or 14% of the population of the United States. A Poisson regression model is used to integrate the information across this growing number of sites. FoodNet has shown that there are substantial geographic differences in the incidence of many infections, that are not explained by differences in laboratory practices, or in reporting; they must reflect variation in the underlying exposure rates to the populations. *Campylobacter* infections are five-fold higher in California than in the other sites; *E. coli* O157 infections are two-fold more common in the Northern states than in the South, and *Salmonella* infections are particularly common in the Southeast. Identifying these regional differences as true and real is the first step towards explaining them. Longitudinal surveillance has also identified important time trends in the incidence of these infections. Compared to 1996, the most recent data for 2003 shows significant reductions in the incidence of *E. coli* O157 infections of 42%, of *Campylobacter* 28% of *Yersinia enterocolitica* 49%, and of *Salmonella* 17%; the 21% reduction in *Listeria monocytogenes* infections is not statistically significant (CDC 2004b). This surveillance is the central means for tracking our progress towards meeting national goals of 50% reduction in these infections by the year 2010.

The data from FoodNet contributed importantly to a comprehensive assessment of the

burden of all foodborne infections for 1997 (Mead et al 1999). These data are also used in risk assessments of a variety of pathogens, providing secure anchor points with which to ground the estimates generated by those assessments. The utility of a national platform for conducting population surveys of health care seeking behavior, populations based surveillance, and special studies of particular problems identified has become apparent in other federal systems as well. For example, the Australian OzFoodNet program combines the attributes of FoodNet with a distributed outbreak investigation system. In order to compare the reported incidence of infections across countries, it will be critical to conduct "pyramidal" studies to ascertain the degree of under-reporting for the conditions, which may be quite different from one country to the next.

When a new foodborne disease threat emerges, it has been possible to use the flexibility of the FoodNet platform to rapidly assess it. For example, when the concern of human cases of transmissible encephalopathy was raised in 1996, FoodNet sites conducted a snap survey of all neurologists serving their populations, and were able to rapidly report that none had seen a variant Creutzfeldt-Jakob case in the preceding year (CDC 1996). When cyclosporiasis emerged as a new epidemic disease, it was quickly added to the list of infections of concern, and FoodNet began collecting the available diagnoses long before formal national surveillance could begin. When multiply resistant *Salmonella* Typhimurium DT104 and later multiply -resistant *Salmonella* Newport emerged in the United States, the FoodNet platform was used to conduct case-control studies of these infections (Glynn et al 2004, Varma et al 2004).

FoodNet also links to other surveillance initiatives in the United States. The clinical information from FoodNet can be combined with antimicrobial resistance information gathered through the National Antimicrobial Resistance Monitoring System for Enteric Bacteria ([www.cdc.gov/narms](http://www.cdc.gov/narms)) to assess the differential health impact of infections with resistant vs susceptible strains. These data, for example were used to show that diarrheal illness caused by fluoroquinolone-resistant *Campylobacter* is of longer duration than that caused by susceptible strains (Nelson et al. 2004). The exposure information from FoodNet case-control studies can be combined with the molecular subtyping data provided by the network of state public health laboratories in PulseNet ([www.cdc.gov/pulsenet](http://www.cdc.gov/pulsenet)) to determine the sources of infection for particular molecularly defined strains of foodborne pathogens. Active population-based surveillance data collected over time helps to guide and assess many of the major foodborne disease prevention programs of the country.

Much recent FoodNet research to date is published in "Studies of Foodborne Infectious Diseases in the United States" Clinical Infectious Diseases, vol 28, Supplement 3, 15 April 2004. FoodNet reports and publications are available at [www.cdc.gov/foodnet](http://www.cdc.gov/foodnet). The most recent surveillance summary is published in the Morbidity Mortality Weekly report (CDC 2004b), and can be downloaded from <http://www.cdc.gov/mmwr/PDF/wk/mm5316.pdf>.

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